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AD 843844

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DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

ROUTINE DISINFECTION OF HOSPITAL BEDS BY SPRAYING WITH FORMALIN

*Following is translation of an article by H. A. Hirsch
in Munchener Medizinische Wochenschrift (Munich Medical
Weekly) No. 104, Nov. 62, pp. 2348-2351.*

Summary: Hospital beds were sprayed with solutions from 3 to 6% of formalin. When preliminary tests showed that this produced a considerable reduction in the number of germs, beds of the surgical ward were routine-treated by spraying for each new patient.

Control tests carried out after the procedure had been applied for 3 months demonstrated that the number of staphylococci on mattresses, blankets and pillows had decreased by 90% of the findings prior to the institution of the procedure.

The method is very simple and cheap and an effective means for the prevention of staphylococcus infection in hospitals.

It is further recommended that any ward bed, if brought into an operating room, should first be so disinfected and have fresh linen.

The hospital bed is an important agent in the transmission of staphylococci in hospitals (2, 4, 5, 6, 7, 13). It is continually re-infected, by patients carrying staphylococci, with additional germs and thus forms a source of multiple possibilities of infection (fig. 1).

A special risk is constituted by the practice customary in many hospitals to introduce the hospital bed into the operating room. In moving the patient from and to the bed, there is created a veritable cloud of germs (12, 14), as in any handling involving the bed, with a pronounced and an intensified distribution of the germs in the operating room (2) which is regarded by many authors (2, 5, 7, 8) as a main cause of post-operative infection of surgical wounds.

These brief considerations will make it evident that routine disinfection of hospital beds is indispensable for the prevention of staphylococcus infection in hospitals (1, 3, 5, 13). However, effective disinfection of hospital beds encounters considerable difficulties. Under sterilization by heat, wool blankets shrink and become felted. This method is consequently suited only for the so-called washable blankets of cotton or synthetic fiber but such blankets are not being particularly favored, probably mainly because they are not warm enough. Recourse is therefore had to chemical disinfectants; washings in cold solutions of quaternary basic solutions of ammonium or formaldehyde are recommended (3, 18). This is easily possible for blankets but not for mattresses and pillows.

Disinfection with ethylene oxide under pressure is a very advanced method which prevents damage to the bedding (15). However, first cost and operation is very expensive in view of the large dimension of bedding and requires considerable expenditure of labor and organization. The latter is true also of disinfection with ultra-violet radiation. This requires special rooms equipped with ultra-violet radiation installations (16) which frequently cannot be made available in all hospitals. Moreover, only the germs located directly on the surface and exposed to the ultra-violet radiation are killed. The same difficulties are applicable to the portable ultra-violet disinfection equipment recommended by Rau (17) in which five universally articulated ultra-violet lamps are able to disinfect the entire room in 24 hours.

From the bacteriological viewpoint, the standard final disinfection by vaporization of formalin has proved its worth. However, it is scarcely possible to employ this each time when a bed is occupied by a new patient. We therefore attempt to carry out a "partial final disinfection" by spraying the bed with formaldehyde solutions. It was shown that this required only a low solution of formalin producing only a minor odor and requiring only a few minutes per bed so that it can be repeated without difficulty as often as desired.

Material and Method

1) Experimental spraying: Hospital beds were experimentally sprayed with the following solutions: 0.5% chloramine; 3, 5 and 6% formalin. These solutions were sprayed from a distance of about 50 cm directly on blankets, mattresses and pillows first with a simple spray-gun and later with a compressor with an operating pressure of about 4 at (fig. 2 and 3). The spray jets were adjusted so that they produced a strong, relatively narrow cone which reached in a horizontal direction beyond 50 centimeters. The solutions were thus projected under a certain pressure so that they deposited not merely on the surface but also penetrated somewhat into the bedding. Spraying was maintained until a slight degree of moisture could be observed which disappeared however, after a few minutes with the formalin solution. Experimental spraying was carried out immediately after removal of the used linen from beds in the surgical, nursing, and post-natal care wards. Before

and three hours after spraying, blankets, pillows and mattresses were examined by the "pounding" method ("Abklatschmethode") of Kanz (10, 11, 12).

This produced a satisfactory qualitative and quantitative picture of the germ status on the surfaces. That the pounding method determines only the germs capable of contact does not constitute any restriction of indication but represents precisely the germs involved in further distribution, i.e. expresses by count and/or reduction the degree and/or decrease of the risk of infection.

Since the blankets and mattresses were energetically beaten simultaneously with the test-pounding, the dust particles released have therefore been taken into consideration at least in the area of the test surface.

The colonies obtained on the nutrient medium after incubation for 24 to 48 hours correspond to the germ content of a surface of about 80 cm^2 so that a proper understanding of the risk of infection expressed by the staphylococcus count can be derived only by transposing this count, at least on an order of magnitude, to the total surface of the object investigated.

Since we were concerned in our investigation primarily with pathogenic staphylococci, we utilized exclusively specific nutrient media with the additions required for the experiment. The "total germ count" thus determined therefore contains very few gram-negative bacteria because the latter do not incubate well on such nutrient media.

From the colonies suspected of containing staphylococci, a representative count was transferred to and further differentiated in sub-cultures in each case. Only plasma-coagulase positive staphylococci were retained in the findings.

2) Routine Spraying: After the promising results of experimental spraying, routine formaldehyde spraying was instituted in the surgical station. Upon changing patients and, as far as possible, whenever changing bed linen, the nurses sprayed all beds with a 5% solution of formalin in the manner described above.

For this purpose, the beds were sometimes moved into the hall and sometimes left in the room. Pillows, blankets and mattresses were sprayed from all sides. The time required for disinfecting a bed amounts to about 2-4 minutes and requires an average of $50-100 \text{ cm}^3$ per bed.

After 3 months of utilizing routine formaldehyde spraying, 11 beds of the surgical ward were again investigated for their germ content. The individual beds had been sprayed between 1 and 4 times in the meantime. At the time of examination, all the beds investigated contained patients who had occupied them from 1 to 14 days (an average of 3.7 days). Examination by the pounding test was made in the manner described above.

3) Findings: The results of the spraying tests are shown in table 1. A total of 11 beds were sprayed during 4 test days. For each day of tests, the average count of total germs and that of staphylococci is calculated before and 3 hours after disinfection. This produces the percentual reduction of germs by spraying. It will be seen that the staphylococci were especially greatly affected by formaldehyde spraying which produced a reduction of germs of 81-95%. The reduction of the total germ count is also apparent with 53-79% although less pronounced than that of the staphylococci.

Because of the greater intensity of odor and the definite inferiority of chloramine to formaldehyde in regard to staphylococci, chloramine was used only once.

The results of the control test after routine spraying with formaldehyde for 3 months are shown in table 2. We are struck first by the high content of bacteria of the mattresses which was determined also during other investigations in our hospital (1) and other hospitals (4, 6, 16). The reduction of staphylococci after repeated spraying here also amounts to 88 and/or 93% in not freshly disinfected beds. The reduction of total germ count is appreciably less with 20 and/or 41%.

Descretion: The high decrease of staphylococci after the relatively short utilization of formalin for 3 months is rather remarkable if we consider that the beds had been occupied for several days by patients at the time of the test. This would seem to make it possible that a part of the germs found may have been brought into the beds by the new patients which is probably true in particular for the total germs because their number, in contrast to the staphylococci, is much higher after 3 months of utilizing the spray than after a single spraying.

It might be objected that spraying with formalin kills only the germs on the surface without affecting the germs within the mattresses, blankets and pillows. Subsequent making-up of the beds as well as their utilization would produce a release of the germs from the inside to the surface which would quickly destroy the effect of disinfection.

However, the low count of staphylococci on beds which had again been occupied for several days subsequent to the last disinfection indicates that this is not the case. Either there is no or only minor exchange of germs or else the routine disinfection of the surface with the highly volatile formaldehyde leads to an appreciable reduction of the staphylococci in the entire bedding.

Unfavorable side effects did not occur through spraying of a 5% formalin solution. If the beds were sprayed in the rooms, the patients in the adjoining beds sometimes complained of a pungent odor which was quickly dissipated. In regard to the spraying equipment, we might mention that the plunger of the manual spray pistol used initially quickly began to seize with the aqueous formalin solution. We therefore switched to a diaphragm

compressor, weighing 34 kilograms, which is mounted on rubber wheels so that it can easily be manipulated by a nurse.

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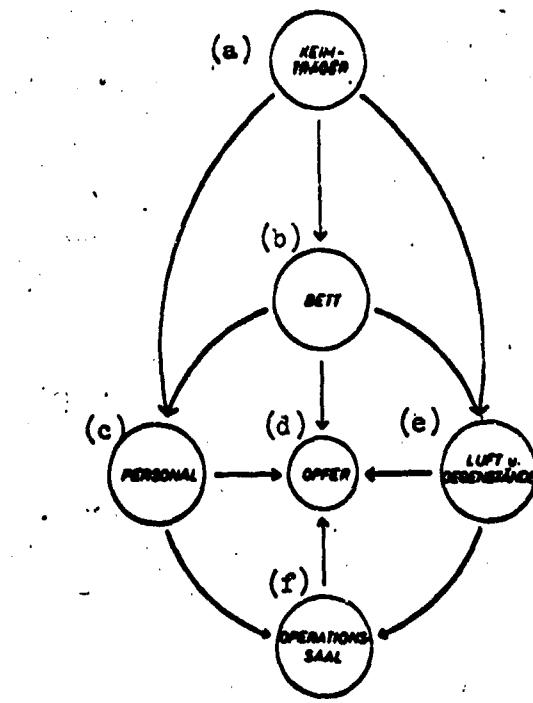


Fig. 1. Diagram of the most important paths of transmission of staphylococci in a surgical hospital division. a - germ carriers; b - bed; c - personnel; d - recipient; e - air and objects; f - operating room.

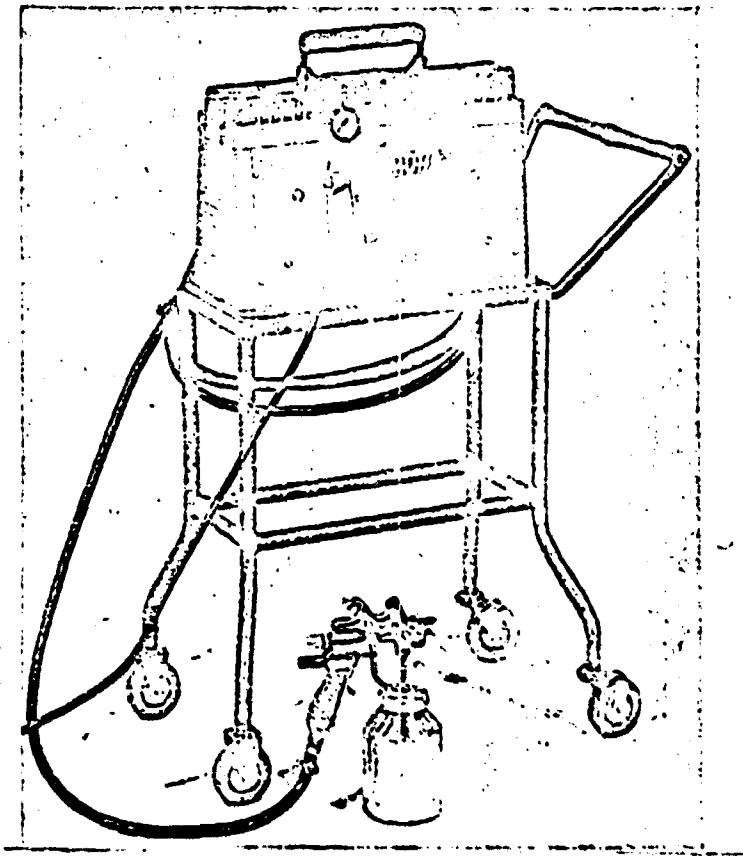


Fig. 2. Two-cylinder diaphragm compressor
(manufactured by Gauting, Munich) mounted
on carriage and provided with spray gun
(operating pressure about 4 at.).



Fig. 3. Routine disinfection of hospital beds with 5% formalin solution.

Legends of Tables

Tab. 1: Verminderung der Keimzahlen und der Staphylocokken auf Matratzen, Decken und Kopfkissen nach einmaligem Besprühen mit Chloroform- und Formalinlösungen.

(a) <i>gerne</i>	(b) <i>Anzahl der Sprühe</i>	(c) <i>Anzahl der Sprühe</i>	(d) <i>Gesamtkeime</i>			(1) <i>Staphylocokken</i>		
			(e) <i>Flurkonzentri. Keimzahl pro Abtaststelle</i>	(f) <i>Keimzähle vor Abtaststelle</i>	(g) <i>Keimzähle nach Abtaststelle</i>	(h) <i>Keimzähle pro Abtaststelle vor 3 Std. nach Desinfekt.</i>	(i) <i>Keimzähle pro Abtaststelle vor 3 Std. nach Desinfekt.</i>	(j) <i>Keimzähle pro Abtaststelle vor 3 Std. nach Desinfekt.</i>
Chloroform 0,5%	1	20	165	41	61	1,5	0,6	60
Formalin 3%	1	20	65	21	53	-	0,3	53
Formalin 5%	3	20	228	49	79,4	10	0,9	91,1
Formalin 5%	4	20	115	23,7	79,7	4,4	0,5	81,4
Formalin 6%	2	20	207	63	76,4	50	2,9	86,3

Table 1. Reduction of total germs and of staphylococci on mattresses, blankets and pillows after spraying once with solutions of chloroform and formalin. a - spraying agent; b - number of beds; c - test areas; d - total germs; e - average germ count per test area; f - before disinfection; g - hours after disinfection; h - reduction of germs in percent; i - staphylococci

Tab. 2: Verminderung der Keimzahlen und der Staphylocokken nach dreimonatigem routinemässiger Anwendung von 5% Formalinspray.

(a)	(b) <i>Anzahl der Sprühe</i>	(c) <i>Anzahl der Sprühe</i>	(d) <i>Gesamtkeime</i>			(1) <i>Staphylocokken</i>		
			(e) <i>Flurkonzentri. Keimzahl pro Abtaststelle</i>	(f) <i>Keimzähle vor Abtaststelle</i>	(g) <i>Keimzähle nach 3 Mo. Spray</i>	(h) <i>Keimzähle pro Abtaststelle vor 3 Mo. Spray</i>	(i) <i>Keimzähle pro Abtaststelle nach 3 Mo. Spray</i>	(j) <i>Keimzähle pro Abtaststelle nach 3 Mo. Spray</i>
(k) <i>Matratzen</i>	17	20	192	113	41	19 ± 5,3	2,3 ± 7	88
(l) <i>Decken</i>	17	20	273	201	20	175 ± 75,3	12 ± 30	93

Table 2. Reduction of total germs and of staphylococci after routine spraying of 5% formalin for 3 months. a - objects sprayed; b - number of beds; c - test areas; d - total germs; e - average germ count per test area; f - before disinfection; g - 3 hours after disinfection; h - reduction of germs in percent; i - staphylococci; k - blankets; l - mattresses.